








## Original Research

# “Improved not only the osteoarthritis but also general health”: A qualitative study on patient experiences with the peak-portuguese e-learning course for knee osteoarthritis self-management

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## ABSTRACT

**Introduction:** Clinical practice guidelines for knee osteoarthritis (KOA) recommend that individuals receive education for self-management. Although education can be offered through different means, including websites, not all internet content is evidence-based. The Physiotherapy Exercise and Physical Activity for Knee Osteoarthritis - Portuguese (PEAK-PT) e-learning course provides updated and evidence-based information on KOA for physical therapists and may be useful for the education and self-management of individuals with KOA.

**Objective:** To assess the barriers and facilitators to engage with the PEAK-PT course from the perspectives of individuals with KOA and understand if the information provided by the course aligned with information about KOA they previously had.

**Methods:** A qualitative study was conducted with nine individuals with KOA who completed the PEAK-PT course. Semi-structured interviews explored facilitators, barriers, and prior knowledge. These three categories informed data analysis using content analysis.

**Results:** Facilitators of PEAK-PT included online accessibility, structured course modules, and downloadable materials. Barriers included technical issues and the need for cultural adaptation. Participants reported improved understanding and motivation for self-management, with some noting that the information provided confirmed what they already knew, while others identified difference between the new content and their prior beliefs.

**Conclusion:** This study's findings suggest that a program developed for clinicians may also be beneficial for individuals with KOA. However, education courses on health conditions for individuals with KOA should be culturally adapted.

## Introduction

Knee osteoarthritis (KOA) is a chronic and progressive health condition characterized by pain, swelling, and joint stiffness that negatively impacts function and quality of life, placing a substantial burden on individuals and the healthcare and socioeconomic systems.<sup>1–3</sup> According to the Global Burden of Diseases study,<sup>4</sup> KOA is now ranked as the

12th leading cause of disability worldwide, with over 364.6 million prevalent and 29.5 million incident cases.

Exercise, education, and weight management are non-pharmacological treatments to improve KOA-related symptoms.<sup>5–10</sup> Guidelines from several international societies (e.g., Osteoarthritis Research Society International,<sup>11</sup> European League Against Rheumatism,<sup>12</sup> American College of Rheumatology,<sup>13</sup> American Academy of

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Orthopaedic Surgeons<sup>14</sup>) reinforce that exercise is a safe and effective non-pharmacological treatment, demonstrating better results in reducing symptoms compared to pharmacological treatment.<sup>11,15</sup> Moreover, guidelines also recommend education for individuals with KOA as it may improve uptake and adherence to physical activity and improve engagement with self-management.<sup>16–18</sup> Education tools may include pamphlets, videos, web-based classes, and knowledge exchange via in-person consultations with a physical therapist.<sup>19</sup> Although the internet provides information about KOA,<sup>20</sup> few websites offer clear evidence-based information currently recommended for the self-management of individuals with KOA.<sup>21</sup>

The Physiotherapy Exercise and Physical Activity for Knee Osteoarthritis (PEAK) was created to address the uncertain quality of online information about KOA. This free online course (<https://www.futurelearn.com/courses/peak>) is based on the best evidence-based clinical practice for the management of individuals with KOA and was originally created for training physical therapists in a clinical trial.<sup>22</sup> The course also provides training about how to deliver KOA care via telehealth. In April 2020, the English version of PEAK became available online for all healthcare professionals,<sup>23</sup> with the goal of supporting high-quality telehealth care delivery for individuals with KOA amidst the COVID-19 pandemic. The course was later translated to Spanish and Portuguese in 2022.<sup>24,49</sup> Previous findings from qualitative research with physical therapists who completed the PEAK highlighted acceptability of the course structure, in addition to participants valuing updated knowledge regarding the management of KOA.<sup>25</sup>

The PEAK contains robust, practical, and informative resources that may be relevant for other healthcare professionals and individuals with KOA.<sup>22</sup> However, the PEAK was designed for physical therapists and it is not known whether the course meets the informational needs of patients with KOA. Understanding whether the PEAK content aligns with information needs, health literacy levels, and preferences of individuals with KOA contributes to the delivery of person-centered, comprehensible, and actionable care. In-depth information about the usefulness of the PEAK for individuals with KOA is currently lacking. Implementation efforts that overlook the perspectives of users and patients may compromise engagement, adherence, and ultimately, intervention effectiveness. Contrarily, being sensitive of these perspectives supports shared decision-making and aligns with the real-world needs of those the interventions aim to benefit.

Therefore, this study assessed the barriers and facilitators to engaging with the PEAK-Portuguese (PEAK-PT) course from the perspectives of individuals with KOA, including whether the information provided aligned with information about KOA they previously had.

## Methods

### Study design

This qualitative study is part of a project to implement physical activity and education for individuals with KOA in Brazil. Data were collected from semi-structured interviews with individuals with KOA and analyzed using content analysis.<sup>26–28</sup> The study was approved by the research ethics committee of the Federal University of São Carlos (UFSCar; CAAE: 60,443,422.0.0000.5504) and followed the Declaration of Helsinki. This study is reported according to the Consolidated Criteria for Reporting Qualitative Research (COREQ).<sup>29</sup>

### Recruitment and eligibility

Individuals with KOA who participated in previous studies of the Laboratory of Muscular Plasticity at UFSCar from April to November 2023 were invited to participate in this study.<sup>30,31</sup> All individuals were informed about the aims and procedures of the study and signed a consent form to participate.

Eligibility criteria included a diagnosis of KOA according to the

clinical and radiographic parameters of the American College of Rheumatology,<sup>32</sup> being able to read and comprehend Brazilian Portuguese, and having access to a computer or device with an internet connection. Participants of both sexes (male/female) were included, with no restrictions on age, body mass index (BMI), or health condition severity. Individuals with a recent history of surgery due to KOA were excluded.

Individuals were recruited using convenience sampling.<sup>33,34</sup> According to Baldin,<sup>35</sup> there is no ideal minimum or maximum number of participants to be included in a study as the focus is on the depth and richness of data collected. Therefore, the number of individuals included in this study was decided upon the experience and perception of the research team, with no interviews being conducted after information from new interviews did not add to the content analysis.<sup>36</sup>

### Procedures

The PEAK-PT course is an evidence-based e-learning course for physical therapists aiming to improve their clinical practice in managing pain, function, and quality of life of individuals with KOA.<sup>37</sup> The training is currently free (albeit for a time-limited duration) through the English-based platform Future Learn (<https://www.futurelearn.com/courses/PEAK-Portuguese>) and divided into four modules/weeks: 1) course introduction; 2) KOA and scientific evidence; 3) physical therapy services by videoconference; and 4) PEAK program. The average time for course completion is eight hours (two hours/week).<sup>22,49</sup>

Participants were invited to join the PEAK-PT at home. Individuals who completed the course were invited for an interview, which took place up to four weeks later following course completion.

Two researchers (HJAS and LF) developed guiding questions and prompts for the interview (Table 1), and HJAS (white, male, physical therapist, with previous experience in conducting interviews and qualitative research) conducted the interviews with study participants. The interview was flexible to address topics raised by the participants, fostering richness of data. Prompts also deepened on barriers, facilitators, benefits of the course beyond KOA, and on how the course content related to prior information about KOA. These categories were defined based on previous research findings<sup>38,39</sup> and informed data analysis.

Interviews were conducted in person or via videoconference (Google Meet). All interviews were audio and video recorded and transcribed verbatim for analysis. To ensure confidentiality, pseudonyms were assigned to each participant.

### Data analysis

Data were analyzed following the content analysis proposed by Bardin.<sup>26,35</sup> A systematic and objective analysis of the dataset was performed to identify patterns or trends. This occurred in three phases: 1) pre-analysis, consisting of preparation of the transcribed material and familiarization; 2) exploration of the material, where words and sentences with information relevant to the study aims were coded after repeated reading; and 3) code grouping broader themes and interpretation under the pre-established categories. The analysis led to a descriptive overview of the perceptions of individuals with KOA about the course.

A discussion session with the co-authors (BTS and LF) was conducted to refine the themes under the pre-established categories. The refined findings were shared with a third researcher (KM, female physical therapist, PhD, with expertise in qualitative research), and the final report was developed.

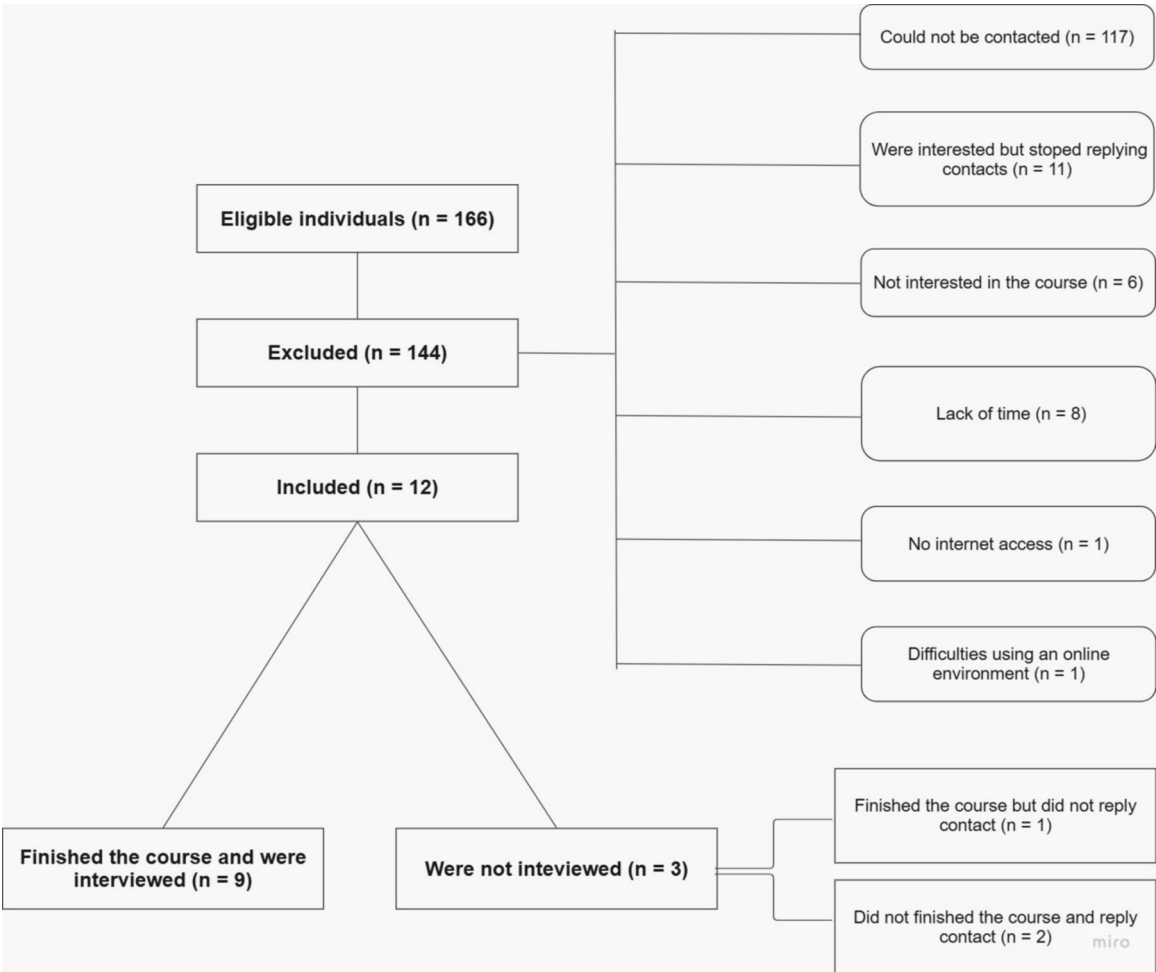
## Results

A total of 166 individuals with a diagnosis of KOA were contacted by telephone with the aim of inviting them to participate in the course, and 144 were excluded for various reasons (Fig. 1). Twelve individuals started the course, but two did not complete it, and one did not respond

**Table 1**  
Guiding questions.

"Tell me about your experience and perceptions after finishing the PEAK-PT course."
"What was the impact of the PEAK-PT course on your health condition?"
"Comment about the barriers when attending the course."
"Comment about the facilitators when attending the course."
"How was your health condition explained to you by healthcare professionals before the course?"
"Was any information in the course different from what healthcare professionals told you?"

PEAK-PT - Physiotherapy Exercise and Physical Activity for Knee Osteoarthritis – Portuguese.



**Fig. 1.** Flowchart of participant selection.

to contact attempts upon course completion. Therefore, nine individuals were interviewed.

Table 2 describes the sample characteristics. Individuals had a mean age of  $59 \pm 7$  years, BMI of  $29.65 \pm 3.01$  kg/m<sup>2</sup>, and were mostly females ( $n = 8$ ; 89 %). Also, all individuals were residents of the Southeast region of Brazil, four (44.44 %) had a higher education level, and five (55.55 %) were actively employed. All individuals reported increased pain in the left knee at rest, with a mean of  $4.11 \pm 2.14$  points on the Numeric Rating Scale (NRS), and five (55.55 %) reported not using pain medication.

The themes developed under the categories “barriers”, “facilitators”, “benefits beyond KOA”, and “absent and conflicting prior information” are presented below. Additional quotes supporting the themes are presented in Supplementary File 1.

**Barriers**

*Need for cultural appropriateness*

Most participants did not report any barriers. However, one individual reported that accessing the course online and having English as the language used by the Future Learn platform was challenging:

**Debora:** Yeah, because there were times when it was in Portuguese and there were times when it was in English, so it got in my way a bit, but it worked.

Another participant elaborated on a potential barrier related to the socioeconomic and educational contexts of the Brazilian population, highlighting traditional and health literacy as important aspects to be considered and adjusted. For example, Maria referred to potential implementation barriers of the PEAK-PT within the Brazilian public health system (SUS).

**Table 2**  
Characteristics of participants.

Pseudonym	Sex	Age (years)	Body mass index (kg/m <sup>2</sup> )	Education level	Household income (minimum wage)	Most affected knee	Pain Numeric Rating Scale(0 to 10)	Symptoms duration (years)	Use of medication
Maria	Female	58	28.58	Complete higher education	1 to 2	Left	3	≥ 20	No
Pedro	Male	61	34.32	Complete higher education	3 to 4	Left	4	≥ 30	Torsilax®
Claudia	Female	56	28.65	Complete secondary education	≤ 1	Left	7	≥ 2	Dipyrone monohydrate
Debora	Female	50	26.99	Incomplete higher education	1 to 2	Left	4	≥ 12	No
Angélica	Female	74	27.97	Complete primary education	1 to 2	Left	5	≥ 20	No
Ana	Female	66	27.78	Complete higher education	1 to 2	Left	0	≥ 0.5	No
Camila	Female	61	29.72	Complete secondary education	1 to 2	Left	3	≥ 4	No
Tania	Female	52	35.26	Complete secondary education	1 to 2	Left	7	≥ 3	Acetaminophen + codeine phosphate
Bianca	Female	59	27.64	Complete higher education	> 5	Left	4	≥ 3	Torxilax®

**Maria:** ...So it should be something more accessible for SUS patients, if that is the idea, right? As I already told you, I worked in SUS for about ten years, and the difficulty they [patients] have in even understanding Portuguese is quite significant, right? And...in its current format, it would not work, it should be a...the development of a new course, or **one fully adapted for lay people**, for SUS patients.

#### Facilitators

##### Course delivery and content

Participants mentioned how the free and online access allowed them to study at their own pace. Moreover, they did not have to leave their homes to perform the exercises recommended by the course, which was observed as an advantage, as shown in the quote below:

**Maria:** A facilitator is being **online**. It was great because we **do not have to commute**, we have no time. So, this was a very **good facilitator**, even a motivator, right? Because sometimes you have a short break in your schedule, and you can advance in the modules.

Participants highlighted that the flexibility of the course was related to the possibility of incorporating the exercises into their routines:

**Camila:** The exercises, I found them very easy to perform. The instructions, too. The **access is simple and free**, right? If you pay for a physical therapy session nowadays, it is very expensive...

**Carol:** The fact that **you are home and doing at your own pace**, when you have your own time, your schedule, you know? It is like I told you, you can access it whenever you want, for as long as you want, right? As long as you manage it, because this course also has a period of 30 days, so you need to manage it to not fall too far behind, right?...But I think that what I saw was really, really healthy and very beneficial.

Another facilitator was the availability of educational material for download, and the way the course content was divided into modules/weeks. Some participants opted to print the content, as it facilitated learning and following the content

**Pedro:** Oh, no... it comes with everything set up, right? On week one, I focused on week one, right? All the items were there, right? I did one at a time, and I also printed the booklets that I found...I can easily print them, so I managed **to print the booklets**. I even made a notebook...four little

notepads, right? And the instructions are very well explained, I did not have... so I followed along one, two, as I finished...once I finished one, the next one was automatically ready, and I just clicked okay. Overall, I think that... I had that commitment to go and do it, right?

Individuals also described being motivated and committed to the course and reported that it was a good initiative that brought new knowledge and encouraged lifestyle changes. The course helped to increase their confidence to perform physical activity.

**Carol:** So... **I realized that if I keep the exercises**, the stretching, if I keep my water aerobics. I work sitting a lot, right, and...there are times when I sit a lot, and this is one of them. And I notice that sitting is worse than standing for my knee, so I get up, I go... you know, I go stretching a little. So, **I think it opened my mind to perform the exercises**.

Therefore, individuals reported positive perceptions of learning more about their KOA through the educational material provided, with videos and images, and accessible, clear, and coherent language.

#### Benefits beyond KOA

Individuals reported that the course brought benefits beyond KOA. The knowledge gained through the course had a broader impact on their health behaviors and daily routines, contributing to lifestyle changes such as increased physical activity and greater awareness of weight management as a strategy to reduce joint overload. Pedro emphasized that the course addressed general health topics, including physical conditioning and weight loss, which he perceived as essential to improving his condition.

**Pedro:** Oh ...I think, in general, not only for osteoarthritis but **also for health**, right? For physical conditioning...they also talk about **losing weight**...which is one of the factors, right? It is essential to reduce the load on the knee, right? I think that this has...will help a lot, right? On my condition.

In addition to delivering technical information, the course also served as a motivational tool.

**Ana:** Oh, it encourages us **to do physical activity**, right? To move around, right? We cannot just stay still, I know we cannot. Oh, it is an encouragement, right? Really a motivation.

Participants appreciated how the course clarified doubts and demystified common misconceptions about KOA. Carol, for example, expressed that the course was dynamic and easy to understand, which helped reduce initial apprehension. She also valued seeing real patient experiences through videos, which helped her strongly connect with the content, also making the information more relatable. This peer modeling appeared to enhance both comprehension and emotional engagement with the material.

**Carol:** *It was good, it solved some doubts, right? That I had, and it clarified things. It showed that the practice of exercises will be a part of it, and that it helps because sometimes we hear so much talk, talk, and talk about it, but we do not see other people, you know? Like I used to see recordings of patients, right? So, I thought it was really cool, very, very nice, really good. I found it interesting, you know, because it was not... because when I started, I thought, "Wow, there are going to be a lot of questions, a lot of things, right?". And...no, it was very dynamic, really, really easy, it was not heavy or anything like that, right? So, I...for me, it was very good, it clarified things, and I liked it.*

Participants also reported that the information from the course contributed to critical thinking about their conditions. For example, some participants aimed to reduce medication consumption and others reconsidered a preconceived idea about the need for knee surgery, acknowledging the benefits and effectiveness of exercises.

**Pedro:** *...I think that the course provides knowledge, so you do not need to do the surgery. Oh, I, I am sure of that. And...I got more confident of not doing the surgery, right? Of not doing the surgery and doing the follow-ups at home...with the exercises. Losing weight, which is one of...right? And also, not taking too many medications.*

#### Absent and/or conflicting prior information about KOA

Participants indicated that previous information provided to them about their KOA was different to the information that was delivered in the PEAK-PT. In contrast, content in the course was intentionally developed with empowering language and a strengths-based approach about KOA, emphasizing self-management, activity maintenance, and focusing on what is possible and positive with regards of quality of life while living with KOA.

**Maria:** *With the exams, right? The imaging, medical reports, and even my physical condition were better than what appeared in the exams, which was believed to be due to the exercise, the physical activity that I do regularly, constantly. That...based on the exams, I was a completely inactive, sedentary person who would be in worse conditions than mine.*

**Angelica:** *"It wasn't much different, I always said that and in the program I also learned that you can't, you can't keep talking... that doctors can't keep talking so as not to embarrass someone, I don't even care anymore. I got used to it. I learned that doctors shouldn't say things to frustrate people so they don't do the exercise"*

One individual reported that their healthcare professional did not even explain about KOA or treatment options to them:

**Tania:** *It was not explained. With the orthopedist, it was not explained that physical therapy exercises could improve it...it was explained that an injection could be given, something like that. So, when I did the course and saw that you feel better by doing specific stretches, and also after I started losing weight, I...and seeing on the online course that these are indeed things that relieve pain, I managed to put it all together, right?*

Other participants had a previous explanation about the condition that framed KOA as a negative and threatening diagnosis, often through imprecise language or medical jargon:

**Bianca:** *...Yeah, so with the knee, the doctor was more specific, even though he used the term "bone-on-bone", right? Which is not very nice,*

*but anyway. But he explained to me that it is really just deterioration due to age.*

## Discussion

This qualitative study explored the experiences and perceptions of individuals with KOA after completing the PEAK-PT. Participants mostly reported facilitators and positive experiences with joining the course, emphasizing knowledge acquisition regarding KOA self-management and quality of life. However, the English language of the online platform was reported as a barrier, alongside the lack of cultural adaptation to the Brazilian context.

According to the participants, the course motivated participants to be more physically active, particularly through the performance of strengthening exercises. This finding reinforces that health education contributes to the self-management of symptoms among individuals with KOA.<sup>40</sup> However, participants reported receiving contrasting information from healthcare professionals about KOA, which caused frustration and fear in many individuals. For example, these deficit-based messages had previously affected participants' engagement in physical activity. Studies indicated that misunderstandings about KOA may reduce the acceptance of non-surgical treatment.<sup>41,42</sup> The belief that physical activity may cause joint damage can contribute to the fear-avoidance behavior<sup>43</sup> and reduced overall mobility, loss of muscle strength, lack of confidence, and fear of falling.<sup>44</sup> Thus, empowering individuals with KOA and healthcare professionals with updated scientific evidence is essential to review the language used to discuss (i.e., explain and understand) this health condition, favoring a strengths-based approach. This collaborative and non-authoritarian approach reduces the authority relationship that the physician has with the patient and actively involves individuals in the care process, improving the therapeutic relationship, and promoting dignity.<sup>45</sup> In this sense, the PEAK-PT course may be a valuable tool for both health professionals and patients.

Prior information may influence the management of the health condition of individuals with KOA, which in our participants, was usually diagnosed solely through imaging exams.<sup>41</sup> One individual reported having their condition explained through an X-ray, and despite having severe KOA, their functional capacity did not match the exam. Indeed, the structural changes observed in X-rays do not correlate to the symptoms experienced by individuals with KOA.<sup>46</sup> The use of negative language when diagnosing KOA is another important fact, as reported by one individual ("bone-on-bone"). This type of language may cause fear in patients, reduce their acceptance of non-surgical treatments based on evidence, or even contribute to the underutilization of key effective treatments, such as physical activity and health education. Therefore, describing KOA as a chronic and complex health condition without focusing on imaging exams and by creating a sense of hope and optimism may be useful during diagnosis. Finally, using positive empowering language is better than impairment-based descriptions.<sup>47</sup>

Participants reported that they could make informed treatment decisions once they understood their condition. For example, one participant decided against pursuing surgery after completing the PEAK-PT course. Although this was not the main goal, it reinforced the raised awareness and value of non-surgical treatments. Also, individuals gained confidence with this new horizon of possibilities for managing KOA. Clinical practice guidelines recommend surgical intervention only when non-surgical strategies are unsuccessful.<sup>11,12</sup>

The PEAK-PT course was originally developed for healthcare professionals, mainly physical therapists.<sup>24</sup> Thus, although individuals with KOA benefited from this resource, a specific course developed for this population might be useful. In this sense, a free online course for individuals with KOA was launched, and it is currently being evaluated in English to fill this gap,<sup>4,6</sup> and a version in other languages, including Portuguese, might contribute to its dissemination. In Brazil, the free

distribution of this type of resource for users of public and private health systems may provide access to quality content, strengthening the public health system.

### Clinical implications

From a clinical perspective, the findings highlight the potential of structured online education programs to complement physical therapy interventions. Given the growing demand for remote healthcare solutions, integrating evidence-based educational resources into clinical practice could enhance patient engagement and self-efficacy. Moreover, expanding the availability of culturally adapted online courses may support public health initiatives aimed at reducing the burden of KOA. In summary, the PEAK-PT course was perceived as a valuable tool for improving self-management among individuals with KOA, though cultural and linguistic adaptations are needed for broader accessibility. Future research should explore strategies for optimizing patient-centered digital education and investigate its long-term impact on adherence and clinical outcomes.

### Limitations

This study presented some limitations. For example, the scope of the study was specific, emphasizing the self-perception of individuals with KOA on the PEAK-PT course. Another limitation is that we only interviewed people who completed the course. In our research, we had two participants who did not complete the course. We tried to interview them to find out why, but we did not receive any feedback. It would have been good to get information from people who started but did not complete the course, as they may have faced barriers. Also, only literate individuals with internet access completed the course and were interviewed. Although reports highlighted the importance of the course, internet access, sufficient digital literacy, time, and engagement with the programs are not always a reality.<sup>48</sup> Thus, future studies should investigate how to improve the management of KOA through educational materials used in collaboration by healthcare professionals and patients during attendances and follow-ups. As a strength, this study may contribute to access to evidence-based information.

### Conclusion

People with knee osteoarthritis reported specific barriers to using the PEAK-PT course, including low digital literacy, limited internet access, and difficulties understanding the content due to educational level. Facilitators included free access, online format, and clear information about the condition and exercise. The course contributed to increased knowledge, correction of misconceptions, and greater motivation for self-care. Despite its potential benefits, cultural adaptation (not just Portuguese translation) is needed to educate this population on their health condition.

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### Role of the funder

The funding agencies did not participate in designing and conducting the study, acquisition, management, analysis, and interpretation of data, writing of the manuscript, or the decision to submit the manuscript for publication. They did not own ultimate authority over any of these activities.

### Ethics committee

Was approved by the research ethics committee of the Federal University of São Carlos (CAAE: 60,443,422.0.0000.5504).

### Patient involvement statement

Obtained. Patients were not directly involved in the design or interpretation of this study

### Data availability

All data collected during the study will be compiled electronically. Requests for data or any form of analysis should be directed to HJAS or TFS. Requesters will be asked to sign a data access agreement. Our host institution still needs a platform for collecting, managing, and disseminating research data. However, as soon as the institution acquires the Research Electronic Data CaPTure platform, the project data will be transferred and stored in this system. Any changes made to the protocol will be reported to the research ethics committee via its national website: <http://plataformaBrazil.saude.gov.br/>.

### CRedit authorship contribution statement

**Hugo Jario Almeida Silva:** Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Validation, Visualization, Writing – original draft, Writing – review & editing. **Livia Gaspar Fernandes:** Formal analysis, Validation, Visualization, Writing – original draft, Writing – review & editing. **Rana S. Hinman:** Validation, Visualization, Writing – original draft, Writing – review & editing. **Julya Perea:** Validation, Visualization, Writing – original draft, Writing – review & editing. **Karime Mescouto:** Formal analysis, Validation, Visualization, Writing – original draft, Writing – review & editing. **Angelica V. Ferrari:** Validation, Visualization, Writing – original draft, Writing – review & editing. **Anderson Aparecido Fogaça:** Investigation, Data curation, Validation, Visualization, Writing – original draft, Writing – review & editing. **Bruno T. Saragiotto:** Conceptualization, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing, Supervision. **Tania F. Salvini:** Conceptualization, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing, Supervision.

### Declaration of competing interest

RSH is one of the creators of the PEAK course and Uni of Melbourne receives royalties from FutureLearn who hosts the course. HJAS, BTS and TFSF helped create the PEAK-PT course.

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### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.bjpt.2025.101528](https://doi.org/10.1016/j.bjpt.2025.101528).

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